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Sectoral Interactions, Input-Stock Adjustment and Fiscal Policy Responses

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Abstract

Efficacy of the fiscal policy is a long standing debate. Mainly, with the resurgence of the monetarists from 1970s, economists became sceptical about the Keynesian prescription of govt. intervention and its beneficial role. Particularly from 1990s there emerged a view, from empirical research, that contractionary fiscal policy may be expansionary and vice versa. Proponents of this view, to support their empirical findings with theory, argued that deficit reduction will increase confidence of consumers and businesses, resulting in increased current spending on consumption and investment. But most of these arguments to contradict the Keynesian results are based on some strong assumptions on expectations. Our paper, which is basically a theoretical study of sectoral interdependence in a macroeconomy, predicts this type of non-Keynesian effects of fiscal policy in a Keynesian framework, without being based on any assumptions on expectations. From our model of industrial interdependence, by simply relaxing the implicit assumption of adequate input stock holdings by the industries, we can show how even in a demand determined market economy with excess demand and excess capacity, multiple equilibria solution can exists, with low level equilibrium trap as a possible solution and how this type of inadequacy of stock of inputs can seize the process of fiscal multiplier and even in the extreme case may result in a contraction of economic activities. We have also found out the levels of the minimum stocks of inputs, the industries must possess to avoid such low level equilibrium trap.

Key words: Industrial Interdependence, input stock, efficacy of fiscal policy

JEL Classification: E12, E62, L52, L98

1. Introduction

With the resurgence of the 'monetarists' in 1970s, Keynesian prescription regarding the regulation of an economy became a debatable issue. Economists became sceptical about the beneficial role of fiscal policy, both from theoretical and also from the empirical ground. More specifically, from 1990s, from empirical research, there emerged a view that contractionary fiscal policy can be expansionary and vice-versa, clearly contrasting the Keynesian result. One of the pioneering works in this field was done by Giavazzi and Pagano (1990). In their study they have tested the Keynesian view versus the "Expectation" view on the fiscal policy. This "Expectation" view stresses the role of current changes in taxes or government spendings as signals of possible future changes, e.g., a fall in current govt. spending may imply lower taxes in future and hence will affect the consumers' and investors' expectations accordingly. They have found in some cases (i.e. for some European countries) this "Expectation" view has a serious claim to empirical relevance. Also, from the more recent studies, the most cited paper of Alesina and Ardagna (2010), support the view that cutting spending will not be contractionary.

Proponents of this view, to support these empirical findings with theory, argue that deficit reduction will increase confidence of consumers and businesses, resulting in increased current

spending on consumption and investment. That is, if consumption demand depends on the present value of the life-time income and agents in the economy believe that reducing the deficit reduces the likelihood of more costly adjustments in the future, such as possible disruptions associated with a fiscal crisis, they expect their future income to be larger and have increased confidence to spend in the present. Basically, these views are based on the principle of Recardian equivalence, which suggests the effect of fiscal expansion on consumption is zero (Barro, 1974)[1].

But the underlying assumptions of this view, i.e. of the principle of Ricardian equivalence, are quite strong and restrictive also. Assumptions like all individuals are identical or all individuals are altruistic, is not at all realistic. Moreover, in an economy, the burden of taxes and transfers due to govt. expenditure also usually fall on and go to different sections of the economy (basically on the rich and to the poor) and hence in calculating the life-time income these two components of govt. budget do not cancel out.

Further, it is said that the episodes of deficit reductions which are found to be successful in empirical studies (like Alesina and Ardagna Study) are associated with those countries which were above or close to the full-employment level (Congressional Research Service, June 6, 2011). But the Keynesian prescription is only applicable to the economy which is operating under full-employment with excess capacity.

The International Monetary Fund has also found spending cuts to be contractionary, consistent with the mainstream view. According to their research deficit reduction in countries with a high default risk on debt tend to be less contractionary than in other countries, but even in these cases expansionary effects are unusual.[2]

Now, towards this long standing, yet unresolved debate, our model of interdependent industries can contribute by giving an alternative route thorough which expansionary fiscal policy can have a negative impact on the economy, without based on all those restrictive assumptions of expectations about the future state of the economy and/or future income, infinite life-span of the planner, homogeneity of all individuals etc. That is with the presence of industrial interdependence in a Keynesian framework, we can show a non-Keynesian type result of negative fiscal multiplier by simply relaxing one of its implicit assumption of adequate stock holding.

Our model basically deals with interdependence among different industries in an economy where one industry's output cannot be stocked or have lesser amount of stock than required. For example, we can cite the case of coal and electricity, the two basic industries with high backward and forward linkage. These two industries are interdependent and electricity cannot be stocked. In such a case, even in a demand determined market economy with excess demand and excess capacity, output locked at the low level can be an equilibrium situation. Then as a comparative static result we can show how expansionary fiscal policy can be contractionary in this framework.

2. The Model

We assume that there exist two interdependent sectors operating in a Keynesian framework.[3] Sector-1 produces output X_1, using input supplied by sector-2, which produces output X_2 and in turn uses input supplied by sector-1. So, each industry faces two types of demand, intermediate input demand and final demand. We also assume fixed coefficient production functions for both the industries as:

$X^s_1 = X_2/a_{12}$ and $X^s_2 = X_1/a_{21}$.

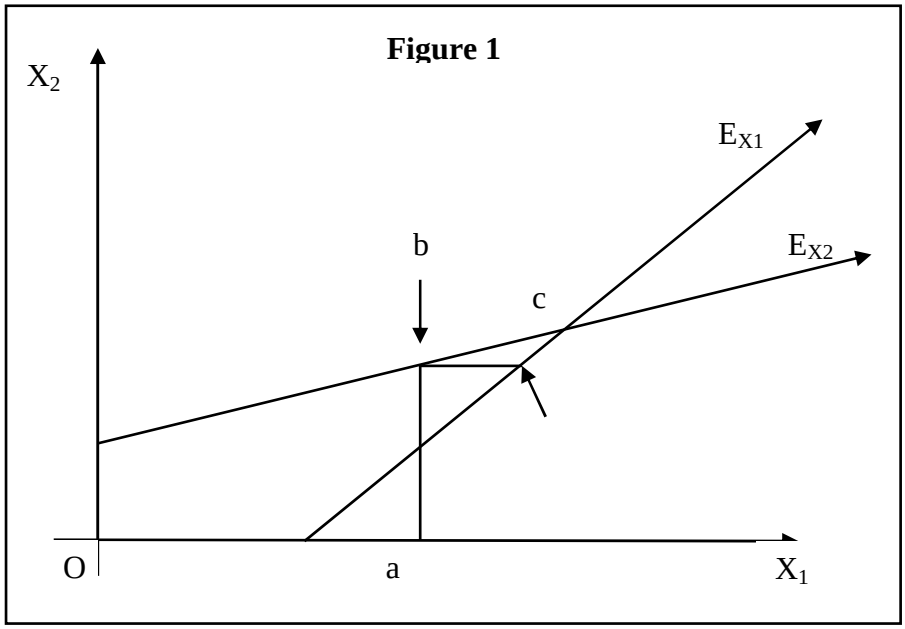
So, the total demand functions facing the industries are:

$x_1 = a_{21}\,x_2 + a\,\{(x_1 - a_{21}\,x_2) + (x_2 - a_{12}\,x_1)\} + F_1 \ldots\ldots (1)$ and

$x_2 = a_{12}\,x_1 + b\,\{(x_1 - a_{21}\,x_2) + (x_2 - a_{12}\,x_1)\} + F_2 \ldots\ldots (2)$, where *a (.)* and *b(.)* are the induced parts and F_i*'s* are the autonomous parts of the final demand. We can treat this autonomous part of final demand as govt. demand.

Now, by solving this simultaneous equations system we can find out the equilibrium level of output as the following figure shows:

Figure 1



Let us denote the equation (1) as E_{X1} and equation (2) as $E_{X2,}$ each representing the total demand facing the firm given the other industries output. For equilibrium to exist we need the slope of E_{X1} to be greater than slope of E_{X2}

Here, we can see at *oa* amount of X_1, demand for X_2 is *ab*, but at *ab* of X_2, we have *bc* amount of excess demand for X_1 and hence output of X_1 increases accordingly. This process will continue until we reach the equilibrium point. But here we should note that the implicit and crucial assumption is both the industries hold adequate stocks of input, so that they can increase their output whenever they are facing excess demand.

Now, contrary to this assumption, we assume, the two interdependent industries do not posses adequate stocks of inputs. So, if industries are not in equilibrium, then these sectors won't be able to meet the entire demand they are facing and will naturally go for rationing. Hence in each sector there will always be a situation of excess demand.

In that case, if industry-1 places $a_{12}x_1$ as its input demand to the industry- 2, it only gets $\theta_1 a_{12} x_1 - \theta_2\{b\,\{(x_1 - a_{21}\,x_2) + (x_2 - a_{12}\,x_1)\} + F_2\} + \theta_3 x_2 + S_{x_2}$, where $0 < \theta_1, \theta_2, \theta_3 < 1$. The second component with a negative sign, captures the effect of final demand on the supply of input and the third component shows the positive impact of an increase in the level of x_2 on the

input supply and S_{x_2} here implies the stock of input (i.e. x_2) industry-1 have from the beginning. Therefore, the production of x_1 is limited to:

$$x_1 = \frac{\theta_1 a_{12} x_1 - \theta_2\{b\{(x_1 - a_{21}x_2) + (x_2 - a_{12}x_1)\} + F_2\} + \theta_3 x_2 + S_{x_2}}{a_{12}}$$

$$\text{or, } x_2 = \frac{(a_{12} - \theta_1 a_{12} + \theta_2 b(1 - a_{12}))}{(\theta_3 - \theta_2 b(a_{21} + 1))} x_1 - \frac{(S_{x_2} - \theta_2 F_2)}{(\theta_3 - \theta_2 b(a_{21} + 1))} \text{ . ..... (3)}$$

So, how much of x_1 will be produced depends here on the availability of input, not on the excess demand prevails in the market. Similarly, for industry 2 we have,

$$x_2 = \frac{\emptyset_1 a_{21} x_2 - \emptyset_2\{a\{(x_1 - a_{21}x_2) + (x_2 - a_{12}x_1)\} + F_1\} + \emptyset_3 x_1 + S_{x_1}}{a_{21}}$$

$$\text{or, } x_2 = \frac{[\emptyset_3 + \emptyset_2 a(a_{12} - 1)]}{[a_{21}(1 - \emptyset_1) - \emptyset_2 a(a_{21} - 1)]} x_1 + \frac{S_{x_1} - \emptyset_2 F_1}{[a_{21}(1 - \emptyset_1) - \emptyset_2 a(a_{21} - 1)]} \text{. ..... (4)}$$

Now solving these two simultaneous equations we can have the equilibrium levels of output, which we can term as a constrained equilibrium, as the figure 2 shows:

As for every level of X_1 (or X_2), due to the assumption of stock inadequacy, there must exists excess demand for X_2 (or X_1) in the market, the C_{x2}(and C_{x1}) curve everywhere lies below the E_{x2} (or E_{x1}) curve and so the equilibrium level of output (X_{1**}, X_{2**}).

Now, equations (3) and (4) give the constraint equilibrium of X_1 and X_2 as functions of S_{x1} and S_{x2}:

$X_{1**} = f(S_{x1}, S_{x2})$-----*(5)*, with f_1 and $f_2 > 0$

$X_{2**} = g(S_{x1}, S_{x2})$-------*(6)*, with g_1 and $g_2 > 0$.

So, from this model we can easily find out the critical minimum level of stocks, which we require to have the unconstraint equilibrium by putting the equilibrium values of X_1 and X_2 from the unconstrained model in the equations (5) and (6) respectively and then solving for the S_{x1} and S_{x2}:

The figure 3 here shows that in an $S_{x1}$and S_{x2} plane we can have iso-stock type of curve indicating a particular level of output that can be produced by different combinations of levels of stocks and as each level of output is a positive function of the amount of stock held, these curves will be of negative slopes. So, with any one combination of the stocks of inputs indicated by the locus of points of the lower kinked thick line, the industries are able to produce X_{1**}, X_{2**}, the constrained level of output. And to produce unconstrained level of equilibrium output industries must have one of the combinations of stocks of inputs indicated by the locus of points of the upper thick kinked line. Here, the corner points of the kinked line shows, how much of input stock should be held by an industry, whose output cannot be stocked by the other industry.

Figure 2

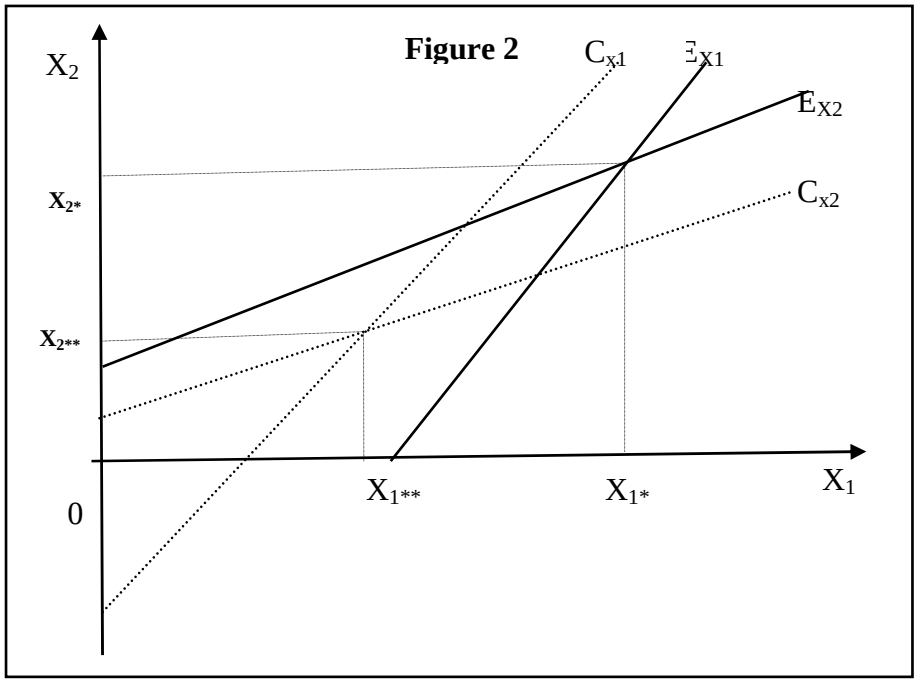
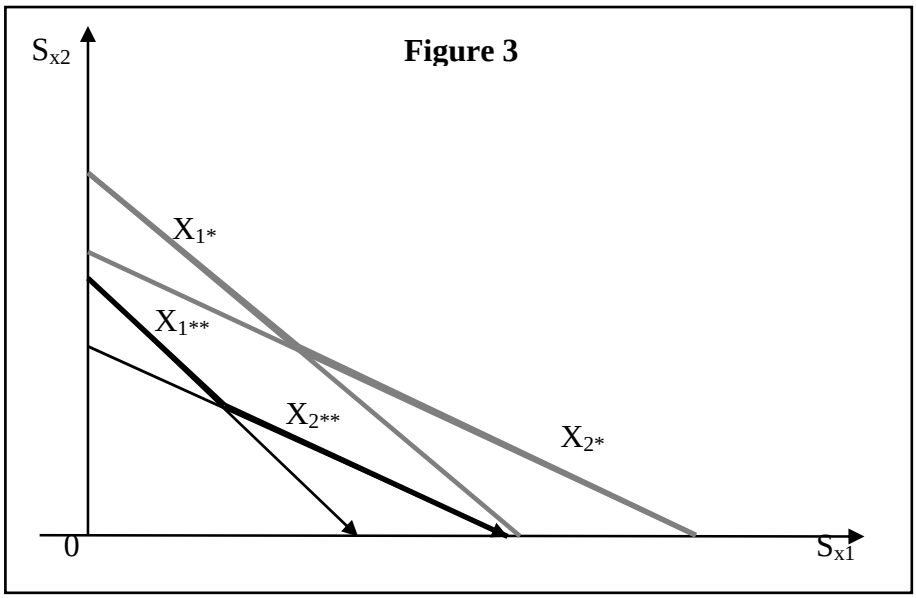


Figure 3



2.A. Comparative Static Results

Here we should note that in the intercept term of the line C_{x1}, the absolute difference between the stock of input available, S_{x2}, and the final autonomous demand or the govt. demand the industry-1 faces, $F_{1,}$ enters negatively and for the line C_{x2}, it enters positively. This implies:

(1) an increase in the initial stock(s) of input(s) can shift the lines outward and making the constrained equilibrium closer to the unconstrained one; and (2) an increase in the govt. demand will shift the lines inward making the constrained equilibrium further away from the unconstraint one.

So, if in an economy, where industries do not have adequate stocks, govt. to boost the economy increases its expenditure, so that the final autonomous demands the industries are facing increase, there may be an ultimate contraction in the economy, given that there exist interdependent industries. This is how we have shown a non-Keynesian result in a Keynesian framework.

2.B. Empirical Relevance of the Model

At the outset, we have cited the case of coal and electricity industry as one of the example of industrial interdependence and where electricity cannot be stocked by the coal industry. So, as our model predicts in this case the electricity industry must possess sufficient amount of coal as stock of its inputs (as the corner points of figure 3 suggests), so that it can meet the existing as well as any increase in demand (both final and intermediate) at time to avoid the low level equilibrium trap. And this argument is strengthened by the fact that India's coal dependence is borne from the fact that 54 % of the total installed electricity generation capacity is coal based and over 70 % of the electricity generated is from coal based power plants.

But, in India, According to the World Energy Council's India Energy Book 2012, growth in coal based generation is constrained due to 92.6% materialization of the requirement of coal. As on 31.03.2011, 29 power stations had critical stock including 13 stations with super critical stock i.e. stock for less than 4 days, where the minimum recommended stockpile is of two- week (some report says 22 days) , by the Central Electricity Authority. And loss of generation of about 7.0 BU during the year 2010-11 due to the shortage of coal has been reported and also loss of generation of about 7.7 BU during the year 2010-11 was due to poor quality or wet coal.

The average Plant Load Factor (PLF) which is an index of utilisation of installed capacity, achieved during the year 2010-11 was 75.07% as compared to 77.68% in the previous year. One of the main reasons of low PLF was coal shortages and receipt of poor quality / wet coal and this problem is also reported for the next fiscal year in the Annual Report of 2011-12, Ministry of Power, GOI.

Here the problem of inadequate coal supply along with receiving wet or poor coal emphasised that there is a long chain of interdependence of industries, it does not end at the low stock problem of electricity industry alone. We can have the indirect effect of electricity shortage on the coal industry via the rail-transportation and so on. So, the electricity industry, with inadequate stock of coal, have faced a pro-long period of short supply , negatively affecting the whole economy as electricity can be considered as an non-substitutable input to the most of the production sector. It is worth noting that the problem is still persisting even for the current fiscal year, 2013-14.

Also, it is said that, hitherto, the development of new coal mines was taking place wherever transport infrastructure for evacuation of coal and its further transportation to various designated

destinations could be managed without much of a problem. But now, more and more new and far-flung coalfields are being taken up for development to meet the increased demand for coal in the country. Initially such developments can go along with road transport. But road haulage is not easy due to lack of road infrastructure of adequate strength. This highlights the need for development of railway facilities for all such locations. Similarly, for handling and transportation of increasing volumes of imported coal, integrated port and railway infrastructure has to be established (World Energy Council' India Energy Book 2012). Also, for speedy evacuation of coal produced, we need railway infrastructure which in turn will demand greater electricity and hence the chance of a logjam, whenever govt. wants to increase its demand to uplift these infrastructural facilities, if the stock problem is not taken care at time.

3. Conclusion

In conclusion, we can say that as electricity, or other infrastructural facilities cannot be stocked by any industry in need of it, the stock of non-infrastructural inputs (such as coal for the electricity industry) to the infrastructural sector must be sufficiently large. Because it will have to first cater the excess demand the industries will be facing in case of increased final demand (say due to expansionary fiscal policy), at least at the first stage where production will be taking off, so to smoothly move on to the equilibrium path as the figure 1 shows. Otherwise the economy cannot reap the beneficial effect of the expansionary fiscal policy even with excess demand and excess capacity. Thus, when applying the Keynesian prescription, we must not only take care of the fact that economy is running with excess capacity but make sure that in presence of industrial interdependence, industries also possess the minimum required level stocks, as figure 3 indicates.

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Notes :

1.Here the assumption is consumers are altruistic towards their future generations i.e. they not only gets utility from his/her own consumption but also from the consumption of their future generations and hence their consumption depends on the present value of the life-time disposable income of their family which is infinitely lived, instead of the present value of his/her own disposable income. So, in this case when govt. increases its current expenditure by deficit financing rather than by raising taxes then individuals expect a future increase in taxes of equivalent amount by the govt. to pay back these loans and hence their life-time income (i.e., of their own and future family's) remain unchanged and as it is assumed that all families are identical, current consumption expenditure, as a result, does not alter.

2. A summary of this debate can be found in an IMF working paper by Hemming, Kell, and Mahfouz (2002); and also in a Congressional Research Service paper by Gravelle and Hungerford (2011).

3.Implies that prices are assumed to be fixed and with appropriate choice of units we have made the prices of both the goods equal to one.

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